**Advanced
Receiver
Research**

Installation Guidelines for ARR GaAsFET Preamplifiers

GaAsFET preamplifiers offer significant improvements in noise figure, gain, 1 dB compression and 3rd order intercept characteristics over bipolar, JFET and dual-gate MOSFET types. Preamplifiers utilizing GaAsFET devices require some special care in installation not normally associated with the other types. GaAsFETs are designed for microwave use so the internal structural dimensions are extremely small, therefore operating and breakdown voltages are considerably lower. Additionally, the GaAsFET device contains no internal protection such as back-to-back, gate-source diodes as used in dual-gate MOSFETs. For these reasons, the GaAsFET preamplifiers are more easily damaged than bipolar, JFET or dual-gate MOSFET types. Nevertheless, properly installed preamplifiers will provide years of trouble free operation.

ARR GaAsFET preamplifiers have built-in protection against:

(1) normal static buildup at input. ARR GaAsFET preamplifiers incorporate a resistive bleeder for normal wind, rain and snow static plus reasonable lightning charge buildup. This bleeder is not capable of protecting against extremely close or direct lightning strikes. If the preamplifier is to be installed in a particularly harsh environment, some form of external static protection device may be necessary.

(2) reverse power supply voltage.

(3) power supply transients. All GaAsFET preamplifiers use an onboard power conditioning circuit to provide the GaAsFET device with a clean and stable supply voltage.

The built-in protection circuitry eliminates many of the problems encountered with GaAsFET preamplifiers. Other potential problems may exist in certain installations and it is the installer's responsibility to ensure against them. Two areas of concern apply to all installations:

(1) difference in ground potential between power supply, input and output connections. Verify that the dc power source ground and the preamplifier input and output coaxial cables (shields) are all at the same ac and dc potential before installing the preamplifier in the system. This test is easily and quickly performed with a VOM or similar instrument. A check should also be performed before installing the preamplifier in a bench test setup for performance verification. Leakage currents from older test equipment can damage GaAsFET preamplifiers. Always use a ground lead between the dc supply ground and the case (ground lug) of the preamplifier. Do not rely on the coaxial cable shields for an adequate ground.

(2) use a crowbar protected power source. The ARR GaAsFET preamplifier is capable of withstanding power supply surges to 40 vdc. Some dc supplies can produce voltages in excess of this value should regulator or pass transistor failure occur. Crowbar protected power supplies will limit the output voltage to some predetermined level usually below this value.

GaAsFET Preamplifiers in Repeater Service

Preamplifiers placed in service on some repeaters may be subjected to certain potentially destructive conditions. Since repeaters are quite often located in harsh environments, area lightning, wind, rain and snow static can cause device failure. This problem is normally eliminated through the use of a bandpass/band reject type duplexer rather than the plain band reject type. The bandpass cavity of a bandpass/band reject duplexer allows the input of the preamplifier to see only a narrow window of the spectrum centered on the receive frequency. Potentially harmful static buildup at all other frequencies is shunted to ground in the cavity, effectively eliminating the problem. Use of a plain band reject type of duplexer produces quite a different effect. When cavities are used only in the reject mode, the preamplifier sees the entire radio spectrum except for the narrow window centered on the transmitter frequency. The bandwidth over which the destructive voltage can build up is tremendously greater for the plain band reject duplexer. For systems already using a band reject duplexer the addition of a single bandpass cavity will provide the appropriate protection. An additional bonus in using a bandpass/band reject duplexer system is that possible interference causing out-of-band signals are eliminated.

GaAsFET Preamplifiers in Transceive Systems

When using tower mounted or indoor preamplifiers in a transceive system, coaxial relays must be used to switch the preamplifier out of the line during transmit periods. Several relay configurations are possible and the system depicted in Fig. 1 is the simplest, most commonly used and, unfortunately, the most likely to cause preamplifier failure. In this case a voltage from the transceiver is used to activate the coaxial relays during transmit to remove the preamplifier from the circuit. The problem with this system is that a finite amount of time is required for the relay arm to change position. Most relays have actuation times of 25 milliseconds or more. At the moment the transmitter is keyed, rf power from the transmitter is applied to the output of the preamplifier until the relay has time to break the circuit. In many cases, bipolar, JFET and dual-gate MOSFET devices are able to handle this short burst of power. GaAsFETs will not. This system can be made to function by using appropriate relay sequencing. RL1 and RL2 should be activated immediately upon transmit, with an ordinary dc relay (or suitable solid-state circuit) introducing an appropriate time lag before unbiasing the power amplifier. Operated in this manner, RL1 and RL2 will have time to switch before rf power flows through them.

The best system for preamplifier control consists of one coaxial relay and separate transmit and receive feedlines as outlined in Fig. 2. In this system the preamplifier output is connected to the receiver input at all times. Under no circumstances can transmitter rf power be applied to the preamplifier. RG-8 or similar cable may be used for the receive feedline, as loss in this line does not significantly affect noise figure. As shown, the coaxial relay is normally in the transmit position and therefore the preamplifier is automatically taken out of the line when the station is shut down. This arrangement protects the preamplifier from damage caused by nearby lightning strikes when the station is not in use. A separate receiver input connection is required with this system so minor modifications may have to be made to transceivers that do not have this option.

The coaxial relays chosen for use should have adequate isolation for the transmitter power level. Minimum acceptable levels are as follows:

Transmitter Power	Relay Isolation
10 W	40 dB
20 W	43 dB
100 W	50 dB
200 W	53 dB
400 W	56 dB
800 W	59 dB
1600 W	62 dB

When in doubt about a particular relay always measure the isolation before installing it in the system.

Preamplifiers Mounted Within Transceivers

ARR supplies preamplifiers without case and connectors for mounting within transceivers. Preamplifiers are normally wired between the transceiver antenna transmit/receive relay (or PIN diode switching) and the input to the existing receiver. The same precautions outlined in the previous section, relay sequencing and relay isolation, apply.

NOTE: Never install a preamplifier directly to a transceiver antenna terminal even for receive only or test purposes. Most transceivers, even with microphone and key removed cycle through the transmit mode briefly during initial power up. This instant of transmitter power is sufficient to cause preamplifier failure. Powering up the transceiver first and then connecting the preamplifier may alleviate the initial power up problem. However, should the power main or transceiver dc supply drop momentarily the transceiver power up problem will occur.

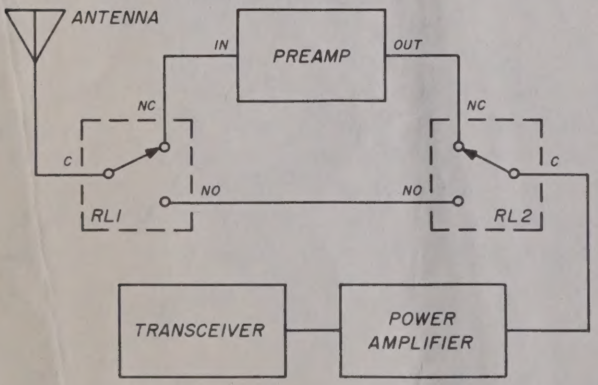

Fig. 1

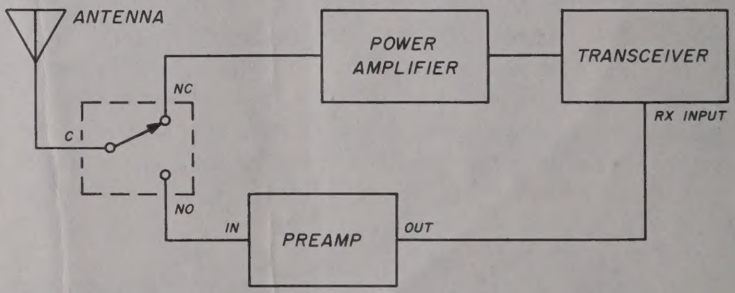

Fig. 2

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